PI.10 Laboratory Test Results of an On-Line Real-Time Alpha Radiation Measuring Instrument for Liquid Streams

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Abstract

The Department of Energy (DoE) has a need for an on- line, real - time instrument for assaying alpha emitting radionuclides (uranium and the transuranics) in effluent waters leaving DOE sites, to assure compliance with regulatory limits. Alpha emitting radioisotopes, such as U238/U234 and Pu239, are rated by the U.S. EPA as class A carcinogens with very low regulated limits in water, uranium also has a high chemical toxicity. 'The EPA proposed maximum concentration limit (MCL) for uranium in public drinking water supplies is 20 ppb (30 pCi/l, equivalent to an emission of 58 alphas per minute in 1 liter of water) . For reference, the world's sea water has a uniform uranium concentration of 3.3 ppb.

Thermo Power Corporation, Tecogen division, a Thermo Electron company, is developing the Thermo Alpha Monitor (TAN) . a real-time, field-deployable alpha monitor based on sample preconcentration and subsequent detection with a solid-state silicon wafer semiconductor. The instrument will serve to monitor effluent water streams (Subsurface Contaminants and Mixed Waste Focus Areas), and will be suitable for process control of radioactive remediation and operations, such as monitoring scrubber/process/rinse water radioactivity levels (Mixed Waste, Tanks, Decontamination and Decommissioning and Plutonium Focus Areas) . It will be applicable for assaying other liquids, such as oil, or solids after proper pre-conditioning.

Due to the short range *of* alpha particles in water (40 μm), it is necessary now to intermittently collect samples of water and send them to a central laboratory for analysis, A lengthy and costly procedure is used to separate and measure the radionuclides from each sample. Large variations in radionuclide concentrations in the water can go undetected due to the sporadic sampling. In addition, even when detected, the reading may not be representative *of* the actual stream concentration.

In current TAM laboratory tests, readily observable peaks are evident at very low levels, to 10 parts per trillion natural uranium

(15 femtocuries per liter), or 1/2000th the EPA's drinking water limit of 20 ppb, which is well under the program's goal of 30 pCi/l. In addition, the Thermo Alpha Monitor technology has responded to 20 ppb natural uranium (30 pCi/l) in under a half hour, well under the program's goal of a one- to 12-hour instrument response time. Laboratory testing successfully quantified isotonically 1.5 pCi/l (2 ppb) total uranium in Carlisle, Massachusetts potable groundwater, comparing quite favorably with 0.68 pCi/l levels of soluble uranium and 1.35 pCi/l total uranium that were measured by conventional analysis methods. Laboratory testing also successfully isotopically analyzed a 600 ppb uranium sample obtained from DOE's Fernald, Ohio Site. Overall, TAM technology has demonstrated a linear dynamic range over greater than six decades of concentration, from 10 parts per trillion (15 fCi/l) to 10 parts per million (15,000 pCi/l) natural uranium, including levels of natural thorium between 100 parts per trillion (17 fCi/l) and 1 part per million (172 pCi/l). Upcoming Phase II work will perform a field test of TAM at the DOE-Oak Ridge, Tennessee site.

With an analysis time of minutes, depending on the concentration and statistical accuracy, this new technology represents a significant advance towards direct identification and quantitative assay of alpha emitters in aqueous streams, both on-line and in real time, Compared to present methods of analysis, TAM will be most cost-effective, with a simple payback period of less than 5 months, oftentimes as short as several weeks.

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